



Aalborg Universitet

AALBORG UNIVERSITY
DENMARK

Anisotropy and enthalpy relaxation of calcium aluminosilicate glass fibers

Ya, min; Deubener, Joachim; Yue, Yuanzheng

Publication date:
2007

Document Version
Publisher's PDF, also known as Version of record

[Link to publication from Aalborg University](#)

Citation for published version (APA):
Ya, M., Deubener, J., & Yue, Y. (2007). *Anisotropy and enthalpy relaxation of calcium aluminosilicate glass fibers*. Abstract from Silicate Melt Workshop, La Petite Pierre, France.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal -

Take down policy

If you believe that this document breaches copyright please contact us at vbn@aub.aau.dk providing details, and we will remove access to the work immediately and investigate your claim.

Anisotropy and enthalpy relaxation of calcium aluminosilicate glass fibers

M. Ya¹, J. Deubener¹, Y. Yue²

¹ Clausthal University of Technology, D-38678 Clausthal-Zellerfeld, Germany

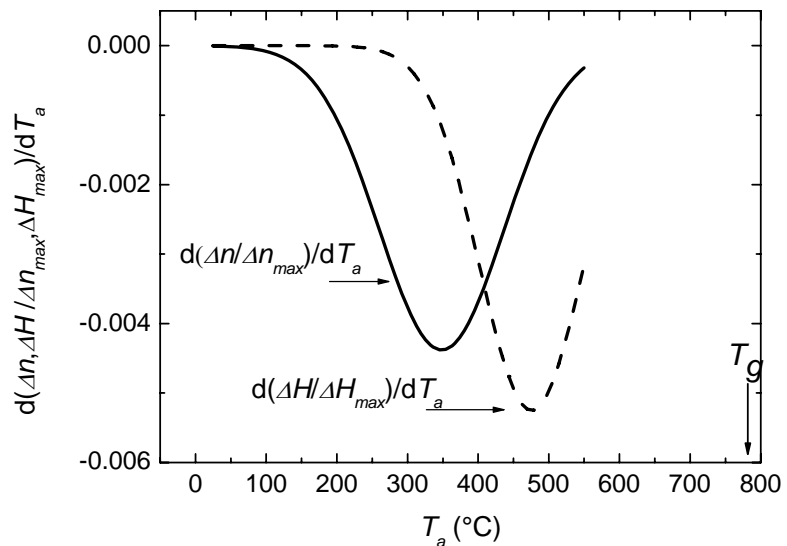
¹ Aalborg University, DK-9000 Aalborg, Denmark

Upon fiber drawing, a silicate melt is thermally quenched and mechanically stretched. Cooling rates $>10^6$ K/min of quenched glass fibres lead to higher enthalpy state of liquids, thereby, to higher fictive temperature than regular quenching (e.g. 20 K/min) of bulk glass products [1], whereas stretching results in structural anisotropy of glasses, i.e. a certain degree of preferred structural orientation along the axial direction of the fibers, which is quantified by the optical birefringence [2].

Optical birefringence and calorimetric studies have been conducted with respect to structural relaxation of calcium aluminosilicate glass fibres. Simultaneous relaxation of both anisotropy and excess enthalpy (relative to the enthalpy of a glass cooled at the standard rate of 20 K/min) upon static annealing and dynamic heating is observed, both of which can be described using the Kohlrausch function. However, there is a striking difference between the birefringence and the excess enthalpy relaxations. The birefringence decays much faster than does the excess enthalpy, i.e. the temperature at which relaxation is fastest, is located for the excess enthalpy at 475°C ($\approx 0.71T_g$) and for the birefringence at 348°C ($\approx 0.59T_g$), indicating that anisotropy is much more unstable than the excess enthalpy during annealing (Fig.) [3]. These observations also imply that the birefringence decay results from fast relaxation of local structure, while the enthalpy relaxation results from slow relaxation of larger domains of the network.

Fig.:

First temperature derivative of the anisotropy relaxation index ($\Delta n/\Delta n_{\max}$) and the enthalpy relaxation index ($\Delta H/\Delta H_{\max}$), where ΔH is the remaining amount of the excess enthalpy of the fibers (relative to the enthalpy of the standard-cooled fibers) after a certain degree of annealing (180 min at T_a), and ΔH_{\max} is the total excess enthalpy of the fibers before annealing.



References

- [1] Y. Z. Yue, J. deC. Christiansen, S.L. Jensen, Determination of the Fictive Temperature for a Hyperquenched Glass (2002) Chem. Phys. Lett. **357**, 20-24.
- [2] J. Deubener, L. Wondraczek (2004) Anisotropic alkali silicate glasses by frozen-in strain, in: H. Li (Ed.) Melt chemistry, relaxation, and solidification kinetics of glasses, The American Ceramic Society, Ceram. Transact. **170**, 47-56.
- [3] M. Ya, J. Deubener, Y. Yue (2007) Enthalpy and anisotropy relaxation of glass fibers, J. Am. Ceram. Soc., *accepted*